Resource efficiency means using fewer virgin raw materials. Increasingly, cement plants are turning to industrial byproducts and materials that otherwise would be discarded as sources for the basic elements needed for cement making.

After completing detailed analyses on their chemical characteristics to determine the effect on process chemistry and facility emissions, many cement plants can utilize byproducts from the electric power industry as a raw material in the manufacture of the clinker—the intermediate product in the process—or as an ingredient in the final cement product.
Three general classes of byproducts from electric power plants can be used in the manufacture of portland cement: fly ash, bottom ash / boiler slag, and flue gas desulfurization (FGD) materials.

Fly ash and bottom ash / boiler slag contain large amounts of silica and alumina as well as calcium and iron [TFHRC 2002]. All of these components are needed in the cement manufacturing process. FGD materials can replace the natural gypsum that must be added to the final product to control the setting of concrete [EPRI 1999]. Currently, over 55% of U.S. portland cement plants use one or more of these byproducts to produce clinker or cement.

Fly Ash
Fly ash is the fine, powder-like material collected by the particulate matter control devices at coal-burning power plants. Depending on chemical and physical attributes, some fly ash can be blended into the final cement product or used at the ready-mixed concrete plant. In the appropriate proportions in concrete, fly ash decreases permeability and increases long-term strength [ACAA undated].

The American Coal Ash Association (ACAA) reported that 70 million short tons of fly ash was produced in 2003, with over 12 million short tons used in concrete, concrete products, and grout. Over 3 million short tons of fly ash was used in kiln feed for the manufacture of clinker or cement [ACAA 2004].

In 2005, 39 portland cement plants were using fly ash as a raw material in the manufacture of clinker, and 3 plants were blending fly ash into one or more cement products. (Figure 1 shows the locations of the plants utilizing fly ash.)

Bottom Ash and Boiler Slag
These materials are collected in the bottom of coal furnaces at electric power plants. Bottom ash is a dark gray or black, sand-like material that collects in the bottom of dry-bottom boilers. Boiler slag is retained as a molten material in wet-bottom boilers and is discharged into quenching water where it crystallizes and fractures into black glassy pellets [TFHRC 2002].

Nearly 20 million tons of bottom ash and boiler slag was produced in the United States in 2003. Over 500,000 tons of it was used in kiln feed for the manufacture of clinker and over 310,000 tons used in concrete, concrete products, and grout [ACAA 2004].

In 2005, 21 portland cement plants were using bottom ash / boiler slag as a raw material in the manufacture of clinker (as shown in Figure 2).
Flue Gas Desulfurization Materials
At some coal-fired power plants, sulfur dioxide emissions are controlled by flue gas desulfurization (FGD) systems in which lime or limestone reacts with the gaseous sulfur to form calcium sulfate or calcium sulfite. This material is referred to as synthetic gypsum. When properly processed, the calcium sulfate can be used at portland cement plants to replace the natural gypsum that must be added to the final product to control the setting of concrete [EPRI 1999].

In 2003, over 420,000 tons of synthetic gypsum from FGD systems was used at portland cement plants out of the nearly 12 million tons produced by the electric power industry [ACAA 2004]. In 2005, 20 portland cement plants were using FGD materials in the cements (as shown in figure 3). [more]

USE OF POWER PLANT BYPRODUCTS

The Buzzi Unicem plant in Chattanooga, TN, uses all three byproducts from coal-fired power plants: fly ash, bottom ash, and synthetic gypsum. The fly ash and bottom ash are part of the kiln feed and become part of the clinker, while the gypsum is used in the finish mills in the production of portland cement.

USE OF SYNTHETIC GYPSUM

The synthetic gypsum produced by coal-fired power plants is often a moist material. At the CEMEX plant in Knoxville, TN, it is mixed with cement kiln dust—a byproduct from the production of clinker—to improve material handling. The result is a powder that can be added to the clinker in the finish grinding mill to produce portland cement. This allows the beneficial use of two byproducts: one from the electric power industry and the second from the cement manufacturing process.

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Portland Cement Association is a trade association representing cement companies in the United States and Canada. PCA’s U.S. membership consists of 46 companies operating 102 plants in 36 states. PCA members account for more than 97% of cement-making capacity in the United States and 100% in Canada.

References


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